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# Factors affecting consumer assessment of eco-labeled vehicles

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## Abstract

A statewide sample of Maine registered vehicle owners is used to examine factors that affect their assessments of eco-labeled conventionally fueled passenger vehicles. The study focuses on developing an empirical and theoretical framework with which to model vehicle choice decisions under eco-labeled conditions. Particular attention is paid to how eco-information may affect the two-stage vehicle purchase process. The study builds upon environmental economic and psychology literature in examining the role of personal characteristics such as perceived effectiveness of consumer purchase decisions and perceptions of the eco-labeled products as factors in the vehicle purchase decision. It was found that environmental attributes of an eco-labeled passenger vehicle are significant in the purchase decision. The eco-information is considered in the vehicle purchase decision, but is generally not considered at the class-level decision.
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## 1. Introduction

The health and welfare of the environment has become an increasingly important public issue for consumers' nation and worldwide. Respondents to a study by the Northeast States for Coordinated Air Use Management (2003) ranked air pollution in the top nine public issues that citizens were most concerned about. The transportation sector has been identified as one of the principal contributors to the degradation of air quality throughout the US, although consumers typically underestimate the extent to which motor vehicles are a causal factor (Kurani and Turrentine, 2002). The need for politically viable options to mitigate the effects of traditional fueled vehicle emissions has led policy makers to consider the use of eco-labels and their widespread use suggests that eco-labels are perceived by some as an effective method of altering consumer behavior.

For eco-labeling initiatives to meet with success, not only must consumers hold preferences for environmentally preferred products, they also must be able to comprehend the information being presented and be willing to pay a premium for these products. Thus, the success of labeling programs may be contingent upon the characteristics of the consumer as individuals with varying personal characteristics, such as environmental perceptions and social norms, face eco-labeled products in the market. Here we test some of the individual

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characteristics that have been hypothesized to influence the effectiveness of eco-information, as applied to environmentally preferred passenger vehicles. While the examination of the role of personal characteristics is increasingly prevalent in the evaluation of eco-label initiatives, previous work has not addressed the two-stage nature of the vehicle purchase decisions. We investigate how labeling and personality characteristics may have different impacts on each stage of the vehicle purchase decision.

The light-duty vehicle market is the focus of the analysis because of the actual,[1] and perceived, contribution of these vehicles to air pollution, and because traditional command-and-control approaches, while very effective in cases where consumers have no impact on outcomes, such as the elimination of lead in gasoline (40 CFR Part 80),[2] are less effective when consumers can choose vehicles with different levels of environmental performance.[3] This is seen most dramatically in the shift from cars to light-duty trucks (including sport utility vehicles (SUVs),[4] minivans, and pickup trucks) witnessed in the US since 1979 when light-duty trucks had a market share of 9.8% to 2003 when their market share rose to 50.1% of all new passenger vehicles (National Highway Transportation Safety Administration, 2004). Since light-duty trucks certify to lower (less stringent) emission standards than cars, the result is a lessening in the effectiveness of that the overall tightening of car and truck standards would have had, had consumers not shifted their purchases. In addition, although there are several studies (e.g., Brownstone et al., 1996; Bunch et al., 1996) indicating a demand for 'greener' vehicles, no one has studied whether an eco-information program is effective in altering consumers' attitudes toward, or purchases of, environmentally preferred vehicles.[5] It is, thus, an open question whether informed customer choice in the light-duty market will lead to these outcomes.

The purpose here is to contribute to an understanding of whether vehicles displaying environmental characteristics would alter consumer behavior. Specifically, we develop and test a model explaining a person's propensity to buy an environmentally preferred vehicle as a function of their personal and vehicle characteristics. Moreover, this work may inform evolving transportation policies, particularly in the state of Maine.

## 2. Theoretical model

To provide framework for measuring changes in consumer vehicle choice behavior due to changes in eco-labeled product, one first needs to know how perceptions of environmental quality enter an individual's utility function (defined in terms of a purchase occasion or decision). The utility evaluation can be represented by the indirect utility function[6]

$$V = v\{\mathbf{E}, \mathbf{p}, M, \mathbf{I}\} \tag{1}$$

where $\mathbf{E}$ is a vector of perceived environmentally related assessments for $J$ products (i.e., $\mathbf{E} = [E_1^S, \ldots, E_J^S]$), $\mathbf{p}$ is a corresponding vector of prices and M denotes income. $\mathbf{I}$ is a vector of individual characteristics such as environmental perceptions, stock of prior knowledge regarding environmental issues and socio-demographic characteristics.

The method that extracts and translates environmental information into an assessment of a product's environmental impact can be viewed as a 'household production' process by which an individual combines her prior environmental knowledge ($K$), cognitive abilities ($A$), time ($T$) and the environmental information ($S$) presented during the evaluation phase of the purchase decision.

Thus, we could model the assessment process during the purchase decision as:

$$E_j = f(S_j, K, A, T) \tag{2}$$

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[1] Light duty vehicles are one of the major sources of carbon dioxide, nitrogen oxide, carbon monoxide and volatile organic compound emissions in the US.

[2] The Code of Federal Regulations (CFR) Title 40 Part 80 prohibits the use of lead additives in motor vehicle fuel.

[3] For example, Congress's recent inability to increase fuel efficiency standards.

[4] A sport utility vehicle (SUV) is a vehicle that combines the characteristics of trucks (hauling) and cars (passenger carry space).

[5] The research presented within this article will focus on the effects that eco-information programs may have on conventional fueled passenger vehicles, and will not address the case of hybrid vehicles. Throughout this article we will refer to 'greener' vehicles or 'environmentally preferred vehicles'. These terms refer to gasoline-powered vehicles that are classified as low emission by the USEPA.

[6] This model is similar to those used by Teisl et al. (2002).

where $E_j$ denotes the (subjectively) assessed environmental impact of purchasing good $j$ given information set $S$, $S_j$ is the environmental information displayed about product $j$ at the point of purchase (e.g., an eco-label).

The individual's utility, once a choice is made is

$$V_1 = v(E_1(S_1, K, A, T), M - p_1, \mathbf{I}) \quad \text{if } y_1 \text{ is chosen} \tag{3}$$

where $E_1$ is the assessed environmental impact of product $y_1$, $S_1$ represents the environmental information presented on $y_1$'s label and $p_1$ is the price of $y_1$. Typically, the researcher cannot observe $E_1$, or many of its components, directly necessitating use of the reduced form:

$$V_1 = v(S_1, M - p_1, \mathbf{I}) \quad \text{if } y_1 \text{ is chosen} \tag{4}$$

The reduced form is not unduly limiting given the policy-relevant variable, $S_1$, is retained.

Under a random-utility framework, there are unobservable components of the utility function; the individual's utility function is treated as random with a given distribution

$$V_j = v\{S_j, M - p_j, \mathbf{I}\} + \varepsilon_j \tag{5}$$

where $\varepsilon_i$ is the unobservable component of the individual's utility function. Therefore, the choice of product $y_1$ by an individual indicates that the utility associated with $y_1$ is greater than any of the other alternatives within a choice set. The probability that the individual will choose $y_1$ is equal to the probability that the utility associated with $y_1$ is greater than the utility of the alternative:

$$\Pr(y_1) = \Pr[v_1\{S_1, M - p_1, \mathbf{I}\} + \varepsilon_1 > v_j\{S_j, M - p_j, \mathbf{I}\} + \varepsilon_j] \quad \text{for all } j \neq 1 \tag{6}$$

The probability of choosing an alternative can then be estimated using one of various dependent variable modeling techniques.

## 3. Methods

The analysis is based upon a 19-page survey used to gather baseline data on the willingness of Maine citizens to purchase environmentally friendly passenger vehicles. Maine, located in the northeastern region of the US bordering on Canada, is a rural state with an economy driven by natural resource based industries and tourism. Maine is highly reliant on personal vehicles, because large areas of the state lack transportation alternatives. This dependence, evident by the fact that 89% of Maine's workforce commutes by passenger vehicle, coupled with Maine's geographic isolation and rural character, creates an ideal scenario to study consumer assessment of vehicles. This section clarifies the methods employed in collecting the data.

- *Sampling and survey administration.* The survey instrument was administered in June of 2004 and 2005, to a representative sample of Maine's motor vehicle owners. The frame was obtained from over 1 million vehicle registration records acquired from the Maine Bureau of Motor Vehicles; the records represent everyone who registered a vehicle in Maine within the previous year. To obtain a representative sample for each year of administration, 2000 records were randomly selected from the frame with approximately 800 records removed each year because they were inappropriate or contained incomplete information.[7] The survey was administered as a three-round modified Dillman between June and August. The total number of respondents to the 2004 survey was 620, with 169 undeliverable, for a response rate of 60%. The response rate in 2005 was 64%, with 695 respondents and 78 undeliverable surveys. Our respondents are similar to the characteristics of the Maine adult population as measured by the recent US Census, except in terms of gender (Table 1). Although our survey respondents are more likely to be male, the proportion of males correctly reflects the underlying percent of males in the vehicle registration data.
- *Survey design.* The survey instrument consisted of seven sections with a total of 41 questions. Sections 1 and 2 solicited respondents' opinions on air quality in Maine, the relationship between motor vehicles and air

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[7] Records were rejected if the: primary address was outside the state, vehicle was listed as homemade, registration was for a non-passenger vehicle (e.g., utility trailers, snowmobiles) or records did not have a valid vehicle identification number (VIN). Multiple registrations were also removed, as were records of vehicles older than 1985 (these individuals were assumed to be not in the new car market).

Table 1
Characteristics of survey respondents and of Maine residents

|  | Maine survey participants | Maine census[a] |
| --- | --- | --- |
| Percent male | 57 | 48 |
| Average age | 56 | 47 |
| Average education (years) | 14 | 13 |
| Percent white | 98 | 97 |
| Average household income ($) | 51,711 | 51,700 |

[a] Data from 2000 US Census; income adjusted to 2004 dollars using Bureau of Labor Statistics Consumer Price Index.
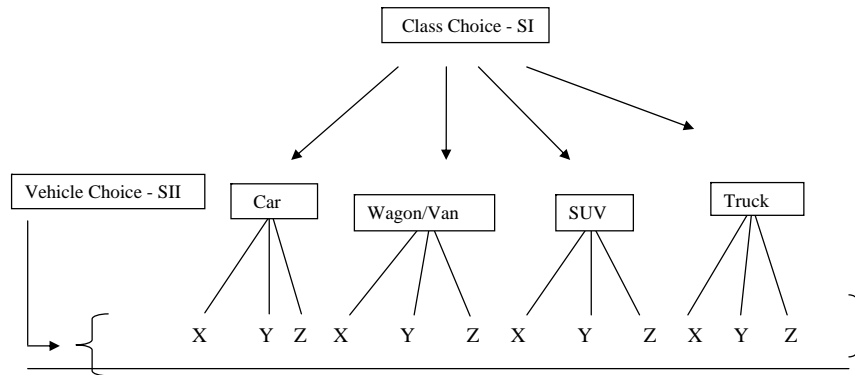


Fig. 1. Two-stage vehicle choice scenario.

pollution and environmental protection in general. Section 3 asked respondents about their current vehicle, including the type of vehicle and the importance of various attributes considered during the purchase decision; in Section 4 respondents were asked about their search and use of environmental information in the vehicle purchase decision. Sections 5 and 6 incorporated an experimental label test and a vehicle choice experiment, respectively. The latter of the two experiments is analyzed in the paper and the design will be discussed below. The final section of the survey, Section 7, collected demographic characteristics.

In the vehicle choice experiment respondents were asked to respond to a two-stage choice scenario; the two stages are designed to reflect the two-stage process of vehicle purchasing (Fig. 1) as indicated by focus group participants (Teisl et al., 2004). In the first stage (SI) participants choose a vehicle class (car, van, SUV or truck). After choosing a vehicle class in SI, respondents were then directed to the second stage scenario (SII), where they then selected one of three vehicles within their chosen class. Respondents were asked to assume that all vehicles were exactly the same except for the information presented.

In SI, respondents were provided with average prices, miles per gallon and scores for criteria pollutants and global warming gases for each of the four classes. The class-level values were generated from two primary sources. Prices for each class were calculated from the National Auto Dealers Association's Appraisal Guides (2004). The range of class-level fuel efficiency and pollutant scores was calculated based on US Environmental Protection Agency's 'Green Vehicle Guide' (2004). The class-level prices are positively correlated with the criteria pollutant scores (i.e., higher prices are associated with better pollutant scores). Miles per gallon ratings were positively correlated with the global warming scores. The standard deviations of data used to calculate the class averages were used to generate ranges of prices and eco-scores, which were randomly assigned to respondents.

In SII, respondents are provided with prices, miles per gallon and scores for criteria pollutants and global warming gases for each of three vehicles. The vehicle-level values were generated from the same sources, and employed the same procedures used to generate the class-level values. Respondents were asked to select one of

the three vehicles; however respondents were also presented the option of not choosing any of the vehicles presented.[8] If rejection of the choice set was selected, information was then collected on the reason for rejection.

## 4. Data analysis

For eco-labeling initiatives to meet the greatest level of success (i.e. result in the largest number of consumers choosing eco-labeled vehicles), a concrete understanding of the individual characteristics that influence a consumer's reaction to eco-labeling must be established. The literature reviewed suggests a myriad of possible explanatory variables involved in the purchase decision, ranging from the traditional set of demographic variables to the more recently examined role of personal characteristics such as perceptions and social norms in the purchase decision. This analysis focuses on the role of personal views and perceptions as factors in consumer decision-making and thus the primary goal of this section is to develop an appropriate empirical model that identifies the variables that influence consumer purchase decisions.

The empirical model for any one individual's choice is

$$\text{Class choice } [C_j] = \Sigma_j \alpha_j + \Sigma_j \gamma_{1j} \text{USE}_1 + \Sigma_j \gamma_{2j} \text{USE}_2 + \gamma_3 (\text{INC} - \text{APP}_j \text{-ACD}_j)$$
$$+ \text{CRITj}^* (\gamma_5 + \rho_1 \text{COMP} + \rho_2 \text{FIO} + \rho_3 \text{PCE} + \rho_4 \text{KNOW} + \rho_5 \text{CON})$$
$$+ \text{GWG}_j^* (\gamma_6 + \kappa_1 \text{COMP} + \kappa_2 \text{FIO} + \kappa_3 \text{PCE} + \kappa_4 \text{KNOW} + \kappa_5 \text{CON}) \tag{7}$$

$$\text{Vehicle choice } [C_{k/j}] = \beta_1 (\text{INC} - \text{APP}_k - \text{ACD}_k) + \text{CRIT}_k^* (\beta_2 + \lambda_1 \text{COMP} + \lambda_2 \text{FIO} + \lambda_3 \text{PCE}$$
$$+ \lambda_4 \text{KNOW} + \lambda_5 \text{CON}) + \text{GWG}_k^* (\beta_3 + \tau_1 \text{COMP} + \tau_2 \text{FIO} + \tau_3 \text{PCE}$$
$$+ \tau_4 \text{KNOW} + \tau_5 \text{CON}) \tag{8}$$

where $C_j$ and $C_k$ are discrete choice variables indicating an individual's choice of the $j$th class (either CAR/VAN,[9] SUV or TRUCK) and the $k$th vehicle (vehicle $X$, $Y$ or $Z$), respectively. The class-level intercept terms ($\alpha_j$) are employed as a means of capturing unobserved class-specific characteristics. The variables USE$_1$ and USE$_2$ were constructed from respondents' answers on a five point Likert scale as a means of measuring the importance that respondents place on specific vehicle-related uses. USE$_1$ measures the average importance (1 = not at all important; 5 = very important) a respondent places on using their vehicle to commute to work and to transport family. USE$_2$ is a similar measure to quantify the average importance a respondent places on using their vehicle for recreational or work-related hauling. A positive $\gamma_{1\text{CAR}}$ is expected because people who require a vehicle for commuter uses are more likely to choose the CAR/VAN class. We hypothesize respondents who require their vehicle for hauling purposes will most likely choose a TRUCK over a CAR/VAN; this would indicate a negative $\gamma_{2\text{CAR}}$. We do not hold strong priors on the $\gamma_{j\text{SUV}}$ parameters since SUV's have characteristics that fall in between those of cars and trucks.

Willingness to pay is a function of both price and income. In turn, the joint variable (INC – APP$_j$ – ACD$_j$) was created, where INC denotes the respondents' annual household income. APP denotes the annual cost of purchasing the vehicle and ACD denotes the annual cost of driving. We calculated an annual purchase price for each vehicle provided in the choice scenario (using an interest rate of 6% and a payment period of 5 years). In addition, the annualized vehicle price was adjusted upward by 10% to include insurance and tax costs. The annual cost of driving (ACD) variable was created utilizing the formula: ACD = [1/MPG ∗ MILES ∗ CPG ∗ 1.93], where MPG is the miles per gallon stated in the choice scenario for the vehicle, MILES denotes the annual number of miles driven by respondents, CPG is equal to $2.16 – the average cost per gallon of gasoline noted during the times of the survey administration.[10] The last term (1.93) weights the annual gasoline costs in order to include annual maintenance costs. APP and ACD is intended to capture how ownership

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[8] Few individuals chose the 'do not choose' option; these observations are not used in the analysis.
[9] Testing indicates the original nesting structure (Fig. 1) created instability in the parameter estimates and that it was not appropriate to have VAN as a separate nests. Once VAN was combined with the CAR nest, the model became stable. VAN was combined with CAR as the two are considered to be substitutes from the consumer standpoint, as both may serve as family transport vehicles. We recognize that from an emissions standpoint, VAN may be most closely related to TRUCK.
[10] The average price of gasoline during the 2004 survey administration was $1.95, and was $2.37 during 2005.

Table 2
Results of factor analysis: rotated factor loadings

| | FIO | PCE | COMP |
|---|---|---|---|
| Most people willing to pay higher prices to protect environment | **0.68** | −.06 | −0.07 |
| Science will solve our environmental problems | **0.58** | −0.11 | 0.16 |
| Most people do their part to protect the environment | **0.56** | 0.50 | −0.03 |
| My lifestyle can have an impact on the environment | 0.18 | **−0.72** | 0.08 |
| Air pollution laws are already strong enough | 0.07 | **0.64** | 0.16 |
| It is too hard for someone like me to do much about the environment | 0.03 | **0.50** | 0.19 |
| Vehicles that produce less pollution are probably more expensive | 0.05 | 0.03 | **0.81** |
| Vehicles that produce less pollution probably have lower performance | 0.01 | 0.18 | **0.75** |

and driving costs affect the purchase decision; we anticipate that as a vehicle/class becomes more expensive to own or drive, a respondent will be less likely to choose that vehicle/class. The parameter estimates on the monetary variables ($\gamma_3$ and $\beta_1$) should be positive; this would indicate that individuals would be less likely to purchase a vehicle/class with higher relative prices (note: as the annual purchase and driving costs increase, the monetary variable decreases).

CRIT and GWG denote the criteria pollution scores and the global warming scores presented to respondents for each class and vehicle. Both eco-scores were presented on a scale of 1–10, where 10 represented the cleanest emission record. It is expected that the coefficients on CRIT and GWG will be positive indicating that higher scores will increase likelihood of purchase.

Interaction variables were created to test the effect various personal characteristics may have on a consumers' use of the eco-information. The questionnaire included nine questions meant to elicit responses consistent with the personal characteristics hypothesized to influence consumer response to eco-labels. We used factor analysis as a data reduction tool (and as a consistency check) on eight[11] of these questions to develop the three psychological variables used as model variables (Table 2). COMP, FIO and PCE are the variables constructed by using this factor analysis.[12] The factor analysis indicates that individuals have three underlying factors influencing their responses to these nine questions. Factor 1 (FIO) reflects a faith in others; Factor 2 (PCE) relates to a persons perceived consumer effectiveness and Factor 3 (COMP) measures a person's perceived compromise needed when buying a greener vehicles.

Faith in others has recently been recognized as a separate construct in empirical studies including work by Henry and Gordon (2003) who found that the behaviors of others influenced the participants in their study as drivers often felt no personal responsibility for vehicle air pollution because they noted worse offenders. Grolleau (2001) also addressed the issue of consumers free-riding on environmental benefits from eco-friendly products (i.e., everyone enjoys better air quality when an eco-friendly vehicle is purchased). He notes that perceptions of others may lead to free-ridership if a consumer believes that a good will be purchased by others. In this event, the parameter on FIO would be negative as higher faith in others leads to decreased likelihood of purchasing a vehicle. He also notes that an 'assurance problem' may also exist. A consumer who believes that she is the only one selecting environmentally friendly vehicles may refrain from making the eco-friendly choice because she fears her effort will be wasted (i.e., not enough air quality benefit from just one person buying an eco-labeled vehicle). However, if she perceives that other consumers are purchasing environmentally friendly (i.e., a higher faith in others) she may be more likely to purchase an eco-labeled vehicle as she feels her pro-environmental choice may be part of a larger effort. If this phenomenon occurs in the vehicle market, the sign on FIO would be positive. Given these two possible states of the world the sign of FIO is ambiguous. Studies suggest a consumer's perceived consumer effectiveness, an individual's view of their personal ability to affect the environment through purchase decisions, is positively correlated with an increased willingness to purchase environmentally friendly products (Balderjahn, 1988; Lee and Holden, 1999). Thus, the parameter on PCE is hypothesized to be positive.

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[11] One of the questions was held out to construct a trust in state government variable, not used in the current analysis.

[12] Responses to the questions are from a five-point Likert scale where 1 = strongly disagree, 3 = neutral, and 5 = strongly agree. For simplicity we will not fully discuss the factor analysis procedure here – details are available from first author.

While the above-mentioned constructs may positively influence one's environmental behavior, there are also barriers to environmentally friendly consumption. One such barrier is perceived compromise, where an individual perceives that purchasing environmentally preferred goods entails some increased inconvenience, cost or risk, or entails accepting a decrease in product quality (Stern, 1999). Consumers may see buying an eco-labeled item as a risky behavior if they are unfamiliar with the product or the eco-labeling program (Thøgersen, 2000). As vehicles are a relatively large capital expense, the risk associated with an incorrect decision is clearly high. If a consumer perceives that an eco-labeled vehicle is not an apt substitute for their normal vehicle, they will be less likely to purchase an eco-labeled vehicle, and therefore a negative parameter is hypothesized on COMP.

KNOW is meant to assess the familiarity of a respondent with the link between air quality degradation and passenger vehicle emissions; specifically KNOW is a dummy variable where 1 denotes the respondent indicated that all vehicles pollute about the same when driven; 0 otherwise. We hypothesize that the coefficient on the KNOW variable will be negative; individuals who do not recognize that vehicle classes differ in their contribution to air quality degradation will be less likely to choose a vehicle with cleaner emissions. CON is meant to measure the individuals' general level of concern about the amount of air pollution in Maine (where 1 = not at all concerned and 5 = very concerned). The literature suggests a person's general view of the environment will be a significant factor in promoting eco-purchases, but that concerns more specific to the environmental issues related to the product under consideration will have a greater impact (Hini et al., 1995). As air pollution is the primary environmental consequence associated with passenger vehicles, one can imagine a high level of concern regarding air pollution may influence a consumer's choice of vehicle. We hypothesize that the coefficient on the CON variable will be positive; individuals who have greater concerns about air quality should place more value on the environmental scores.

Given the two-stage nature of the choice, a nested logit is the most appropriate technique in estimating the results for this data set (Heschner and Greene, 2002). Nested-logit models allow for the variances of the random error to be different across groups of alternatives in the utility expressions; this requires scale parameters to be introduced explicitly into the utility expressions (Heschner and Greene, 2002). Consistent with the literature, the two scale parameters here are labeled $\lambda$ (the parameter associated with the class-level utility) and $\mu$ (the parameter associated with the vehicle-level utility). To provide consistency with utility maximization, one of the scale parameters must by fixed (typically at 1). Here we estimate the nested-logit model with $\lambda = 1$; this allows the $\mu$'s to be free. Given our model contains alternative-specific variables this specification is consistent with utility maximization (Heschner and Greene, 2002).

While the existing economic and psychology literatures provide guidance on what explanatory variables should be included in the model, they provide little guidance on whether the variables are important in the class-choice level, at the vehicle-choice level or at both levels in the nesting structure. Given our interest in identifying the form of the model we performed the following analysis on a subset of the data. We first estimated the full model (as presented in Eqs. (7) and (8)), then re-estimated the model (1) without any interaction terms; (2) without interaction terms at the class level only; and (3) without interaction terms at the vehicle level only. We employed log likelihood testing to determine if inclusion of interaction terms was appropriate at the class level; whether the interaction terms were important in explaining differences in individuals' reactions to the criteria pollution scores, the global warming scores or both. We find from these analyses that interaction terms are only important at the vehicle level and they are only important in explaining differences in reaction to the criteria pollution scores.[13] The final estimated model is discussed in Section 5.

## 5. Results

The estimated scale parameters (the $\mu$'s) lead to Inclusive Values (IV) parameters ($1/\mu$) that are in the appropriate range ($0 \leqslant \text{IV} \leqslant 1$) for a utility maximizing individual (Hunt, 2000). Further, the correlation-of-utilities coefficients ($1 - \text{IV}^2$) are relatively close to one indicating the nesting structure seems appropriate given the alternatives within a nest appear to be reasonable substitutes.

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[13] For brevity we will not fully discuss the analyses here. Details are available from first author.

Table 3
Nested-Logit regression results for vehicle selection

| Variable | Coefficient |
| --- | --- |
| Scale parameter ($\mu$) | |
| CAR | 4.384[*] |
| SUV | 3.659[*] |
| TRUCK | 4.302[*] |
| *Class choice* | |
| Car-specific variables | |
| Intercept | 0.958[**] |
| Importance of commuting (USE1) | 0.621[***] |
| Importance of hauling (USE2) | −0.979[***] |
| SUV-specific variables | |
| Intercept | −0.428 |
| Importance of commuting (USE1) | 0.506[***] |
| Importance of hauling (USE2) | −0.575[***] |
| Income – annualized price – annual driving cost (INC-APP-ACD) | 0.084 |
| Criteria pollution score (CRIT) | 0.098 |
| Global warming pollution score (GWG) | −0.055 |
| *Vehicle choice* | |
| Income – annualized price – annual driving cost (INC-APP-ACD) | 0.098[*] |
| Criteria pollution score (CRIT) | 0.053 |
| Global warming pollution score (GWG) | 0.055[*] |
| Green vehicles are poor substitutes (COMP ∗ CRIT) | −0.002 |
| Faith in others (FIO ∗ CRIT) | −0.011 |
| Perceived consumer effectiveness (PCE ∗ CRIT) | 0.004 |
| All vehicle pollute the same (KNOW ∗ CRIT) | −0.018 |
| Concern over air quality (CON ∗ CRIT) | 0.010 |

[*] Indicates significance at 11%.
[**] Indicates significance at 5%.
[***] Indicates significance at the 1%, or better.

The CAR and SUV-specific variables indicate an individual's use of a vehicle is an important determinant of class choice (Table 3). As commuting becomes more important, respondents are more likely to choose the CAR or SUV class relative to choosing the TRUCK class. Conversely, as hauling becomes more important, respondents are more likely to choose the TRUCK class. The class-level decision appears to be primarily based on attributes that consumers have prior information on, such as uses for the vehicle, and may indicate that this is more important than the class-level information we provided them (i.e., the respondent basically ignored the class-level information presented to them).

Vehicle choice is positively impacted by the monetary variable; this indicates respondents are less likely to choose a vehicle as the costs of ownership or driving increases. Further, as income increases respondents are less sensitive to the negative price impact. The criteria pollution score is not significant, however when its impact is jointly tested with personal characteristics these tests indicate significant heterogeneous reactions to criteria pollutant information. The jointly significant positive sign for PCE and CON indicates individuals who believe their purchase habits may be effective in addressing environmental issues, and those who are concerned about Maine's air quality are more likely to choose a vehicle having better criteria pollution scores. The jointly significant negative sign on COMP and KNOW suggests that consumers who see eco-labeled vehicles as a compromise and individuals who believe all vehicles pollute about the same when driven are less likely to purchase the vehicles with better criteria pollution scores. The testing also indicates that consumers with a higher faith in others (FIO) are less likely to purchase a vehicle with better criteria pollution scores. These results indicate that incentives to free-ride may be prevalent in the eco-labeled vehicle market, and that the assurance problem may not be strongly occurring in this market.

The positive significant sign on the global warming pollution score indicates individuals are more likely to choose a vehicle displaying a better global warming score. Given all of the GWG interaction terms were

deemed unimportant implies that, unlike respondent reactions to the criteria pollutant information, there is no heterogeneity in respondent reactions. One potential explanation for this result is the prevalence of global warming information in the media, with specific emphasis on the ties to vehicle pollution. Thus a consumer's stock of prior knowledge with respect to global warming pollutants, the link to vehicles and affect on the environment may be fairly similar across consumers. In contrast, media attention on criteria pollutants is limited. An additional explanation is that as criteria pollutants are currently regulated under the Clean Air Act, consumers may be assuming that federally regulated pollutants are of less concern and require no further action by individual citizens. If this scenario exists, only well-informed citizens may be aware of the role vehicle-emitted criteria pollutants play in air quality degradation.

## 6. Conclusions

The results of the vehicle choice experiment suggests that consumers will consider the emission profile of a vehicle during their purchase decision, if such information is provided (at least with respect to global warming gases).[14] This meets one of the minimum requirements for eco-labeling success: consumers hold preferences for environmentally preferred products. This result also implies a role for eco-information programs to differentiate between vehicles within a class, as consumers do not react to eco-labeling information at the class level but rather at the vehicle level. Second, the modeling process and subsequent testing revealed that individuals with different personal perceptions and norms may react to eco-information differently (at least with respect to criteria pollutants). These findings present an opportunity for policy makers to influence consumer perceptions by including an educational component to any eco-labeling efforts.

## Acknowledgement

## References

Balderjahn, I., 1988. Personality variables and environmental attitudes as predictors of ecologically responsible consumption patterns. J. Business Res. 17, 51–56.

Brownstone, D., Bunch, D.S., Golob, T.S., 1996. A demand forecasting system for clean-fuel vehicles. In: Organization for Economic Co-operation and Development's Towards Clean Transportation: Fuel Efficient and Clean Motor Vehicles. Publications Service, OECD, Paris.

Bunch, D.S., Brownstone, D., Golob, T.F., 1996. A dynamic forecasting system for vehicle markets with clean-fuel vehicles. In: Hensher, D.A., King, J., Oum, T.H. (Eds.), World Transport Research. Pergamon, Oxford.

Grolleau, G., 2001. Eco-label selectivity: a difficult tradeoff between attenuating the 'assurance problem' and allowing efficient strategies of environmental product differentiation. J. Economic Res. 6, 55–68.

Henry, G., Gordon, C., 2003. Driving less for better air: impacts of a public information campaign. J. Policy Analysis Manage. 22, 45–63.

Heschner, D.A., Greene, W.H., 2002. Specification and estimation of the nested logit model: alternative normalizations. Transport. Res. B 36, 1–17.

Hini, D., Gendall, P., Kearns, Z., 1995. The link between environmental attitudes and behavior. Market. Bull. 6, 220–231.

Hunt, G., 2000. Alternative nested logit model structures and the special case of partial degeneracy. J. Regional Sci. 40, 89–113.

Kurani, K., Turrentine, T., 2002. Marketing clean and efficient vehicles: a review of social marketing and social science approaches. University of California Davis: UCD-ITS-RR-020-01.

Lee, J.A., Holden, J.S., 1999. Understanding the determinants of environmentally conscious behavior. Psychol. Market. 16, 373–392.

National Auto Dealers Association, 2004. NADA Appraisal Guides, New Vehicle Price Guide. Available from: <www.nadaguides.com>.

National Highway Transportation Safety Administration (US Department of Transportation), 2004. Automotive Fuel Economy Program Annual Update, Calendar Year 2003, Washington, DC. Available from: <http://www.nhtsa.dot.gov/cars/rules/CAFE/FuelEconUp-dates/2003/>.

Northeast States for Coordinated Air Use Management, 2003. Green Car Labeling Project: Key Research Findings, Northeast States for Coordinated Air Use Management Rockport.

Stern, P.C., 1999. Information, incentives and proenvironmental consumer behavior. J. Consumer Policy 22, 461–478.

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[14] The reactions to emissions labeling is directly at odds with current policy reality; in the US most vehicles display criteria emissions labels but no vehicles display global warming gas emissions.

Teisl, M.F., Roe, B., Hicks, R.L., 2002. Can eco-labels tune a market? Evidence from dolphin-safe labeling. J. Environ. Economics Manage. 43, 339–359.

Teisl, M.F., Rubin, J., Noblet, C., Cayting, L., Morrill, M., Brown, T., Jones, S., 2004. Designing Effective Environmental Labels for Passenger Vehicles Sales in Maine: Results of Focus Group Research. Maine Agricultural and Forest Experiment Station, Miscellaneous Report 434, Portland.

Thøgersen, J., 2000. Promoting Green Consumer Behaviour with Eco-Labels. National Academy of Sciences/National Research Council Workshop on Education, Information and Voluntary Measures in Environmental Protection. Washington, DC.

US Environmental Protection Agency, 2004. Green Vehicle Guide, US EPA, Washington, DC.